[redacted]
Organization:
[redacted]
PostedDate: 06/17/1997 12:34:34 PM
SendTo: [redacted]
CopyTo: [redacted]
ReplyTo:
BlindCopyTo:
Subject: Flow capacity of Yucca Mountain
Body: After I wrote my responses to you two regarding the 30 mm/yr number for the maximum flow through the mountain (averaged over the site), I ran across [redacted] and we discussed this number. My impression from [redacted] was that words may have been said that could cause you to doubt not only the number but the concept of the limit. I urge you to read what I wrote carefully because I think it portrays the essential concept correctly.

[redacted], what I learned from [redacted] is that the fracture conductivity used in his estimates was based on a formulation by [redacted] that modifies the parallel plate picture for roughness and further corrects for this to account for infilling that can narrow the aperture and reduce the conductivity. It is all smart guesswork, but, as I indicated in my note to you, not unreasonable, given the measurements of the TSw permeability values.

I emphasize again that it had better not matter whether the number is 30 mm/yr or 60 mm/yr or any other number because you can never be sure what the fracture conductivity is at a particular location (and that is the controlling number). This creates a problem if the approach to the design basis model development takes the assumptions as accurate representations of heterogeneous media. Hopefully, we are a lot smarter than that.

To: [redacted]
cc: [redacted]
Subject: Re: Rock Carrying Capacity

I have only now gotten back into town to respond to your note. I apologize if this note is not timely.

The 700 m/yr figure I gave you is an estimate of the saturated fracture conductivity of the TSw units. It is based on measurements of the effective conductivity of that unit measured in pneumatic testing in the unsaturated zone and hydraulic pumping where this unit is below the water table. The 30 mm/yr number is based on the estimated effective saturated conductivity of the most constraining of all of the units in the unsaturated zone. The estimate in this case is an area average of the matrix and fracture conductivities. Consequently, although local fluxes can be considerably higher than 30 mm/yr, this value probably is as good an estimate as any for the average over the site (which is the value we decided to put in [redacted] presentation).

The value you should use in your design-basis-model development effort needs to take into account the nature of the flow that you are attempting to represent. The main problem in this regard will be the representation of the fracture flow. If you assume a continuum (effective continuum or dual-permeability) model, you may want to consider the 30 mm/yr value. If you consider any model in which the fractures are represented discreetly (which the Glass data indicate is more appropriate), 30 mm/yr is much less than the bounding value for flow in the fractures.

To: [redacted]
cc:
Subject: Re: Arithmetic

The parallel-plate model says a fracture one meter by 100 microns can support a flow rate of 23 cubic meters per year. If there is just one of these per square meter, then the maximum flow is 23,000 mm/yr. How are you [redacted] getting 30 mm/yr?

Do you still need an answer to this? The actual answer is that we used the estimates of effective conductivity of the UZ units by [redacted] and [redacted] They calculated the effective bulk vertical permeability of each of the UZ units by weighting the measured matrix permeability and the fracture permeability by their respective areas. After multiplying a big fracture permeability multiplied by small area and adding it to a little matrix permeability multiplied by big area, they got a number for most of the units on the order of 35 mm/yr. The PTn gives a number much bigger than 35 mm/yr (because the matrix permeability is so large), but the flow through the mountain is constrained by the smallest of the permeabilities in the series.

The key number of course is the fracture permeability and I do not know the [redacted] basis for their guess at this value. Let me give you the numbers I ran that caused me to think they were not unreasonable. My numbers are different than yours. The measured value of the saturated fracture conductivity of the TSw units is about 700 m/yr (much lower than the estimates based on the cubic law). These measurements include pneumatic testing in the UZ and pumping at J-12 and J-13 in the SZ (where the TSw is below the water table). There is also a USGS survey of the hydraulic properties in the region that is consistent with this estimate. If you use 700 m/yr for 100 micron fractures and assume these fractures are spaced every 2 meters or so, you get about 35 mm/yr.

To: [redacted]
cc:
From: [redacted]
Date: 06/04/97 12:23:07 PM
Subject: Rock Carrying Capacity

[redacted] worked with [redacted] and me on the 30 mm/yr estimated number. But, in giving this number to the [redacted] on Friday I need to more clearly state qualifying conditions. For example, the 30 m/yr is -like most of our other numbers- an average based a certain set of assumptions--the key one here is that rainfall is episodic and during very high intensity storms most of the rainfall would be rejected. I would like to discuss this in more detail with you, [redacted], [redacted] and [redacted] Perhaps we can get together late next week.

To: [redacted]
cc: [redacted], [redacted], [redacted], [redacted]
From: [redacted]
Date: 06/04/97 11:22:38 AM
Subject: Rock Carrying Capacity

[redacted]

[redacted] tells me your dry run went very well this morning. Congratulations on boiling down a really complex subject.

There was one area that might be confused. [redacted] said you said that the rock would only carry 30 mm/yr before flow would choke and the water table would rise. On April 9, [redacted] told me that the carrying capacity (primarily in the fast fractures, I think) was 700 m3/m2/yr, which is 700,000 mm/yr. This is more intuitively correct to me. Surely the fractures could drain much much more than one inch of standing water per year. [redacted] number says we could drain a lake over 2000 ft deep thru these fractures.

Please let me know if I was confused by [redacted] April 9 statement.

[redacted]